

**COURSE STRUCTURE OF M. Sc. SYLLABUS TO BE IMPLEMENTED FROM
2008-09**

Semester I **(30 cr.)**

Course No.	Title of course	Credits allotted
BO 1.1	Plant Systematics I (non-vascular plants)	4
BO 1.2	Biochemistry and Plant Physiology	4
BO 1.3	Genetics & Plant Breeding	4
BO 1.4	Environmental Botany	4
BO 1.5	Practicals based on BO 1.1	6
BO 1.6	Practicals based on BO 1.2 & BO 1.3	6
BO 1.7	Practicals based on BO 1.4	2

Semester II **(28 cr.)**

BO 2.1	Plant Systematics II (Vascular plants)	4
BO 2.2	Cell Biology	4
BO 2.3	Molecular Biology & Genetic engineering	4
Bo 2.41—BO 2.44	Optional (Any one)	4
BO 2.41	Plant- Organism Interaction	
BO 2.42	Post Harvest Technology	
BO 2.43	Plant Biomass Production	
BO 2.44	Natural Plant Products	
BO 2.5	Practicals based on BO 2.1	6
BO 2.6	Practicals based on BO 2.2 & 2.3	6

Semester III **(30 cr.)**

BO 3.1	Developmental Botany	4
BO 3.2	Plant Diversity, Resource Utilization and conservation	6
BO 3.3	Plant Biotechnology and Bioinformatics	4
BO 3.4	Tools and Techniques in Botany	4
BO 3.5	Biostatistics	2
BO 3.6	Practicals on BO 3.1	5
BO 3.7	Practicals based on BO 3.3, 3.4 and 3.5	5

Semester IV **(12 cr.)**

BO 4.1	Project work (9 cr.) + Seminar (1 cr.)	10
BO 4.2	Seminars and Review Writing	02

Notes:

1. The internal assessment and Term end Examination will be according to the norms of credit system.
2. There shall be at least two field visits for semester I, II and III followed by submission of reports.

BO1.1 PLANT SYSTEMATICS I NON VASCULAR PLANTS

CREDIT I

PLANT SYSTEMATICS –TAXONOMY VS SYSTEMATICS, TOOLS OF SYSTEMATICS	5L	
ALGAE AND THEIR POSITION IN “DOMAINS AND KINGDOMS” SYSTEM ‘TRENDS IN CLASSIFICATION OF ALGAE, ECONOMICS IMPORTANCE.	3L	
CHLOROPHYTA – STRUCTURE AND EVOLUTION OF THALLUS , REPRODUCTION AND LIFE HISTORIES WITH REFERENCE TO ORDERS OF GREEN ALGAE.	5L	
CHAROPHYTA AND EULENOPHYTA – STRUCTURE, REPRODUCTION AND INTERRELATIONSHIPS.	2L	

CREDIT II

PHAEOPHYTA – GENERAL ACCOUNT OF MORPHOLOGY, ANATOMY, REPRODUCTION AND LIFE HISTORIES.....	3L	
RHODOPHYT – CLASSIFICATION, THALLUS STRUCTURE, REPRODUCTIVE AND REPRODUCTION STRATEGIES AND LIFE HISTORIES.....	3L	
CYANOPHYTA – ULTRASTRUCTURE, THALLUS ORGANIZATION, HETEROCYST.....	2L	BRIEF
INTRODUCTION TO CHRYSOPHYLA, XANTTOPHYLA, BACILLARIOPHYLA, DINOPHYTA.....	2L	
CHROMISTA- GENERAL CHARACTERS, CLASSIFICATION UP TO ORDERS	5L	

CREDIT III---MYCOLOGY (20 L)

1.PRESENT STATUS OF FUNGI,FUNGAL TYPES WITH REFENCE TO MODE OF NUTRITION.	(2L)	
2.GROWTH FORMS IN FUNGI: HYPHAL GROWTH,MYCELIAL HABIT AND MODIFICATION, DIMORPHISM.	(3L)	
3.REPRODUCTIVE TYPES,MATING SYSTEMS,PHYSIOLOGY OF REPRODUCTION.	(1L)	
4.SPORE DISPERSAL MECHANISMS IN FUNGI.	(2L)	
5.CLASSIFICATION SYSTEM AS PROPOSED BY ALEXOPOLOUS,MIMS AND BLACKWELL (1995)	(1L)	
6. STUDY OF THE FOLLOWING SUBDIVISIONS:		
I) MYXOMYCOTINA:STRUCTURE,LIFE CYCLE,PHYLOGENY AND INTERRELATIONSHIP OF MAJOR CLASSES.	(1L)	
II) MASTIGOMYCOTINA:STRUCTURE,LIFE CYCLE PATTERNS.	(1L)	
III) ZYGOMYCOTINA:STRUCTURE,THALLUS ORGANISATION,EVOLUTION OF SEXUAL REPRODUCTIVE STRUCTURES.	(1L)	
IV) ASCOMYCOTINA (INCLUDING LICHENS): THALLUS ORGANISATION, CENTRUM DEVELOPMENT,DIFFERENT TYPES OF ASCOCARPS.	(3L)	
V) BASIDIOMYCOTINA: TYPES AND CHARACTERS USED IN CLASSIFICATION,TISSUE . . . DIFFERENTIATION, FRUIT BODY ORGANISATION.	(3L)	
VI) DETEUROMYCOTINA:TYPES OF CONIDIAL ONTOGENY AND FRUIT BODY ORGANISATION.	(2L)	

CREDIT IV BRYOPHYTES

(10 L)

SYSTEMS OF CLASSIFICATION

(1L)

DISTRIBUTION, MORPHOLOGICAL, ANATOMICAL, REPRODUCTIVE STUDIES AND

COMPARATIVE ACCOUNT OF SPOROPHYTES AND GAMETOPHYTES AND INTERRELATIONSHIPS OF THE FOLLOWING ORDERS :

SPHAEROCARPLES, CALOBRYALES, MARCHANTIALES, JUNGERMANNIALES, TAKKAKIALES, ANTHOCEROTALES, SPHAGNALES,

ANDRAEAELES, POLYTRICHALES, BUXBAUMIALES, EUBRYALES, FUNARIALES , TETRAPHIDALES, DOWSONIALES,

FISSIDENTALES

(8L)

THEORIES OF EVOLUTION OF BRYOPHYTES

(1L)

REFERENCES- ALGAE

1. DESIKACHARY T.V. 1959 *CYANOPHYTA ICAR*, NEW DELHI.
2. KRISHNAMURTHY V. 2000 *ALGAE OF INDIA & NEIGHBORING COUNTRIES I. CHLOROPHYCOTA* OXFORD & IBH, NEW DELHI.
3. MISRA J. N. 1966 *PHAEOPHYCEAE ICAR*, NEW DELHI.
4. PRESCOTT G.W. 1969 *THE ALGAE: A REVIEW*. NELSON, LONDON.
5. SMITH G.M. 1950 *THE FRESH-WATER ALGAE OF THE UNITED STATES*. MC GRAW HILL, NEW YORK.
6. SRINIVASAN, K.S. 1969 *PHYCOLOGIA INDIA*. VOL I & II B.S.I. CALCUTTA.

References- Mycology

Dictionary of the fungi, by Kirk et.al., 2001, 9th edition, Published Wallingford : CABI, ISBN:085199377X .

1. AN INTRODUCTION TO MYCOLOGY , BY R. S. MEHROTRA, K. R. ANEJA, YEAR OF PUBLICATION: 1990, NEW AGE PUBLISHERS, ISBN 8122400892.
2. A DICTIONARY OF PLANT PATHOLOGY (2ND EDITION), PAUL HOLIDAY , CAMBRIDGE UNIVERSITY PRESS 2001 ,HARDBACK 331PP, 7 DIAGS, 21 ILLUS, 21 TABS ISBN 0521594537, £90.00, PAPERBACK ISBN 0521594588 £38.00,
3. Biodiversity of Fungi - Inventory and Monitoring Methods, Edited by Greg Mueller (Editor in Chief), Mercedes Foster, Gerald Bills
Academic Press 2004 Hardback 728 pp ISBN 0125095511 £62.95
4. Biology of the Fungal Cell, Edited by Howard, Richard J.; Gow, Neil
A.R. Springer 2001 Hardcover XVI, 307 pp, 68 figs, 2 in color, 16 tabs ISBN 3540601864 £154.00
5. FILAMENTOUS FUNGI , BY DAVID LESLIE HAWKSWORTH, B. E. KIRSOP, S. C. JONG, ROBERT A. SAMSON, K. TUBAKI, JOHN I. PITT, PUBLISHED 1988, CAMBRIDGE UNIVERSITY PRESS MEDICAL / NURSING ,ISBN 0521352266.
6. FUNGAL BIOLOGY 4TH EDITION, BY JIM W. DEACON, YEAR OF PUBLICATION :2006, BLACKWELL PUBLISHING, ISBN 1405130660.

7. FUNGAL MORPHOGENESIS , BY D. (DAVID) MOORE, YEAR OF PUBLICATION: 1998
CAMBRIDGE UNIVERSITY, PRESS SCIENCE, ISBN 0521528577.
8. FUNGI: BIOLOGY AND APPLICATIONS , BY KEVIN KAVANAGH, YEAR OF PUBLICATION: 2005 JOHN WILEY AND SONS
SCIENCE, ISBN 0470867027.
9. ILLUSTRATED DICTIONARY OF MYCOLOGY, BY MIGUEL ULLOA; RICHARD T HANLIN; SAMUEL AGUILAR; ELVIRA
AGUIRRE ACOSTA, TYPE, PUBLISHER: ST. PAUL, MINN. : APS PRESS, ©2000., ISBN: 0890542570.
10. INTRODUCTION TO FUNGI THIRD EDITION 2007 JOHNWEBSTER, UNIVERSITY OF EXETER, AND ROLAND WEBER,
UNIVERSITY OF KAISERSLAUTERN CAMBRIDGE UNIVERSITY PRESS WWW.CAMBRIDGE.ORG, CAMBRIDGE UNIVERSITY PRESS,
978-0-521-80739-5
11. INTRODUCTORY MYCOLOGY, BY ALEXOPOLUS, CJ, MIMS, CW, AND BLACKWELL, M. 1996. 4TH ED. WILEY, NEW
YORK. ALFORD, RA (1999).
12. MAGIC MUSHROOMS , BY PETER G. STAFFORD, PUBLISHED 2003, RONIN PUBLISHING SOCIOLOGY, ISBN
0914171194.
13. MODERN MYCOLOGY, BY JIM W. DEACON, YEAR OF PUBLICATION: 1997, BLACKWELL PUBLISHING , ISBN
0632030771.
14. MUSHROOMS: CULTIVATION, NUTRITIONAL VALUE, MEDICINAL EFFECT, AND ENVIRONMENTAL IMPACT, SECOND
EDITION , BY PHILIP G. MILES, SHU-TING CHANG, YEAR OF PUBLICATION :2004, CRC PRESS, ISBN 0849310431.
15. PLANT PATHOLOGY, BY: GEORGE N. AGRIOS , FORMAT: HARDCOVER, 922 PAGES, PUBLICATION DATE: JANUARY
2005, PUBLISHER: ACADEMIC PRESS, ISBN-10: 0120445654, ISBN-13: 9780120445653,, LIST PRICE: \$79.95.
16. PRACTICAL MYCOLOGY FOR INDUSTRIAL BIOTECHNOLOGISTS, BY M C SRINIVASAN, PUBLISHER: NEW DELHI : TATA
MCGRAW-HILL, YEAR 2004, ISBN: 0070532265.
17. The Fifth Kingdom (Paperback) by Bryce Kendrick (Author) North America, New York,
Academic Press, Paperback: 386 pages ,Publisher: Focus Publishing/R. Pullins Company; 3rd
edition (August 1, 2001) ,ISBN-10: 1585100226.
18. THE FUNGAL COMMUNITY : ITS ORGANIZATION AND ROLE IN THE ECOSYSTEM , BY J DIGHTON; JAMES F WHITE; PETER
OUDEMANS, PUBLISHER: BOCA RATON, FL : TAYLOR & FRANCIS, 2005., ISBN: 0824723554 9780824723552.
19. THE GROWING FUNGUS, BY NEIL A. R. GOW, GEOFFREY M. GADD, YEAR OF PUBLICATION: 1995,
SPRINGERSCIENCE, ISBN 0412466007.
20. THE PHYSIOLOGY OF FUNGAL NUTRITION, BY DAVID H. JENNINGS, JUENNINGS, YEAR OF PUBLICATION: 1995,
CAMBRIDGE UNIVERSITY PRESS SCIENCE, ISBN 0521355249.

References Bryophyta

- 1) CAVERS, F. 1976. THE INTER RELATIONSHIP OF THE BRYOPHYTA. S.R. TECHNIC (BOOK .
HOUSE), ASHOK RAJPATH, PATNA.
- 2) DYER, A.F. AND DUICKETT, J.G. (ED.). 1984. THE EXPERIMENTAL BIOLOGY OF
BRYOPHYTES. ACADEMIC PRESS.

- 3) PARIHAR. N.S.1980. AN INTRODUCTION TO EMBRYOPHYTA VOL. I. BRYOPHYTA. CENTRAL BOOK DEPOT.
- 4) PREM PURI, 1981. BRYOPHYTES: MORPHOLOGY, GROWTH AND DIFFERENTIATION. ATMA RAM AND SONS, NEW DELHI.
- 5) VASHISHTA, P.C. 1999. BRYOPHYTA. S. CHAND & Co. NEW DELHI.
- 6) SMITH, GILBERTH. CRYPTO GAMIC BOTANY (VOL.II) (BRYOPHYTE AND PTERIDOPHYTE) –
- 7) WATSON E.V. -STRUCTURE AND LIFE OF BRYOPHYTES
- 8) RAM UDAR - BRYOLOGY IN INDIA
- 9) CLARKE .G.C. AND DUKETT J.G.- BRYOPHYTE SYSTEMATICS- VOL. 14,
- 10) KASHYAP, SHIV RAM - LIVERWORTS OF WEST HIMALAYAS AND THE PUNJAB PLAINS-(PART-1)
- 11) KASHYAP, SHIV RAM- LIVERWORTS OF WEST HIMALAYAS AND THE PUNJAB PLAINS-(PART-2)
- 12) DABHADE G.T.- MOSSES OF KHANDALA AND MABLESHWAR IN THE WESTERN GHATS
- 13) MATHUR R.C. – BRYOPHYTA AND PTERIDOPHYTA
- 14) CHOPRA R.N. AND KUMAR P.K. – BIOLOGY OF BRYOPHYTES
- 15) BOOK OF MOSSES – RICHARDS. P.
- 16) BRITISH MOSSES AND LIVERWORTS -(ED.2) WATSON F.V.
- 17) USES OF BRYOPHYTES – GLIME, JANICE M. AND SAXENA. DINESH

BO 1.2 Biochemistry and Plant Physiology

Credit I - Basics of biochemistry

Structure and properties of water, its biological significance. Ionization of water, pH, acids and bases, dissociation constants, buffers 3L

Protein structure- Amino acids-structure and properties. Weak molecular interactions and secondary, Tertiary and quaternary structure of proteins, domains 5L

Enzymology- Classification and properties of enzymes, units of enzyme activity. Enzyme kinetics – substrate concentration and rate ; Km. Competitive and noncompetitive inhibitors. Covalent and allosteric regulation. Coenzymes, Isoenzymes and co-factors 7L

Credit 2 – Biosynthetic pathways

Building blocks of biological macromolecules – amino acids, sugars, fatty acids, purine and pyrimidine bases. Their biosynthesis and metabolism. 5L

Structure, biosynthesis and metabolism of polysaccharides and lipids.

Their role in plants 5L

Secondary metabolites – Biosynthetic pathways of major classes of secondary metabolites. Examples of each class and their role 5L

Credit 3 – Nutrition, Transport and Bioenergetics

Water uptake, transport and transpiration. Stomatal physiology 3L

Uptake and assimilation of nitrogen, phosphorous and sulphur from soil.

Nitrogen fixation. NUE, WUE Source and sink relationship 5L

Ion and solute transport 4L

Bioenergetics – free energy, changes in free energy during chemical reactions, entropy and enthalpy, high energy compounds, synthesis of ATP, activation energy 3L

Credit 4 – Metabolism

Photosynthesis – Measurement of rate of photosynthesis. Light and dark reactions Photoinhibition, Regulation of photosynthesis, Photorespiration 7L

Respiration – Measurement of respiration rate Regulation of glycolysis, citric acid cycle, pentose phosphate pathway. Terminal oxidation and the cyanide resistant pathway. Terminal oxidation and the cyanide resistant pathway. Gluconeogenesis 3L

Plant growth regulators – types, structure, Biosynthesis and metabolism 5L

Physiological effects

Growth inhibitors and retardants, brassinosteroids, applications

Changes in plant metabolism under stress.

References

Biochemistry and molecular Biology of Plants – B. B. Buchanan, W.

Gruissem and R. L. Jones. American Society of plant physiology, Maryland, 2000.

Principles of biochemistry –A. h. Lehninger

Biochemistry – L. Stryer, Freeman and co., New York, 2002

Biochemistry and Molecular biology –W. H. Elliot and D. C. Elliot, Oxford University press, New York, 1997

Plant Biochemistry – H. W. heldt, Academic Press, California, 2004

Introduction to Biochemistry – T. W. Goodwin and E. I. Mercer, CBS Publishers, New Delhi, 1998

Plant hormones – Ed. P. J. Davis, Kluwer Academic Publishers, Dordrecht, Netherlands 2004

BO 1.3 Genetics and Plant Breeding

(4 Credits)

Credit- 1

Morphological and molecular phenotypes, segregation of single, two or more genes, Pedigree analysis, Incomplete dominance, Epistasis. 3L

Genetic analysis- Mutant screen and complementation test, Chromosomes and heredity - Chromosomal determination of sex, sex linked inheritance, probability in the prediction of progeny distribution, testing goodness of fit to a genetic hypothesis. 4L

Genetics of Eukaryotic organisms, Genetics of mitochondria and chloroplast, cytoplasmic male sterility, maternal effect. 3L

Inheritance of complex traits - introduction to complex traits, causes of variation, genetic analysis of complex traits, artificial selection, correlation between relatives, heritability, dissection of quantitative traits. 5L

Credit- 2

Bacterial genetics: mobile DNA - conjugative and non-conjugative plasmids, insertional sequences and transposons, antibiotic resistance cassettes, multiple antibiotic resistant bacteria, mutant phenotypes, genetic transformation, conjugation and transduction in bacteria, genetic recombination, mapping of bacterial genome. 3L

Phage genetics: plaque formation, phage mutants, Lytic and lysogenic cycles. genetic recombination in lytic cycle, fine structure of rII gene in T4 bacteriophage, lysogeny, specialized transduction, site specific recombination, mapping the bacteriophage genome, genetic map of Lambda (λ) phage. 4L

Eukaryotic Genetics: Recombination, independent assortment and crossing over, mitotic recombination, genetic markers, mapping by 3 point test cross, mapping by tetrad analysis, linkage groups, chromosome mapping and chromosome maps in important crops. 8L

Credit- 3

Cytogenetics: Karyotype, centromere and chromosome stability, dosage compensation, Euploidy, allopolyploidy, and aneuploidy, their origin and phenotypic effects, Cytogenetic behavior. 5L

Structural heterozygotes and their cytological behavior, complex translocation heterozygotes, , Robertsonian translocations, BA translocations.

Alien gene transfer through chromosome manipulation - transfer of whole genome, individual chromosome and chromosome segment, methods for detecting alien chromatin.
4L

Population genetics: Allele frequencies and genotype frequencies, random mating and Hardy Weinberg principle and its implications, test for random mating, frequency of heterozygous genotypes, multiple alleles, differences among population, effect of selection, mutation, migration and genetic drift. Inbreeding - inbreeding coefficient, allelic identity by descent, effect of inbreeding.
6L

Credit- 4

Plant Breeding: Pre & Post Mendelian developments, objectives, Genetic basis of breeding, plant breeding in India. 2L

Patterns of evolution in Cultivated crop species. 1L

Plant Genetic resources: Genetic diversity in plants, centers of origin, distribution and areas of diversity and the primary, secondary and tertiary gene pools. Importance of genetic diversity in crop improvement and its erosion, concepts of biodiversity conservation and regulation.
2L

Reproductive systems, population structure and breeding strategies
Sexual reproduction, (cross and self pollination) asexual reproduction, pollination control mechanisms and implications of reproductive systems on population structures. Genetic structure of populations.
2L

Qualitative and Quantitative traits and their selection methods (Self and Cross pollinated and asexually propagated crops). 5L

Hybridization and its role, Intervarietal and wide crosses. Principles of combination breeding and its application. Hybrid breeding in self and cross pollinated crops. Role of induced mutation and polyploidy in Breeding. 3L

References:

1. Atherly, A.G., Girton, J. R. and McDonald, J. F. (1999) The Science of Genetics. Sauders College Pub. Fort Worth, USA.
2. Burnham, C.R. (1962) Discussions in Cytogenetics. Burgess Pub. Co., Minnesota.
3. Harlt, D.L. and Jones, E.W. (2001). Genetics: Principle and Analysis (4th edition). Jones and Bartlett Pub., USA.
4. Khush, G.S. (1973) Cytogenetics of Aneuploids. Academic Press New York, London.
5. Lewin, B. Genes VIII. Oxford University Press. New York, USA.
6. Lewis, R. 1997. Human Genetics: Concepts & Applications (2nd edition). WCB McGraw Hill, USA.

7. Russel, P.J. 1998. Genetics (5th edition). The Benjamin/Cummins Pub. Co., Inc. USA.
8. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (4th edition). John Wiley and Sons, Inc., USA.
9. David Freifelder, Microbial Genetics.
10. Strickberger, M.W: Genetics (4th edition). Macmillan Publishing Company, New York
11. Griffiths, A.J.F and Gelbart, W.M. (second edition). Modern Genetic Analysis. W. H. Freeman and Company, New York.
12. Singh, B.D. (2005) Plant Breeding: Principles and Methods. 7th edition
13. Allard, R.W. (1960). Principles of plant breeding. John Wiley and Sons, Inc., New York.
14. Chopra, V.L. (2000). Plant Breeding: Theory and Practice 2nd edition. Oxford & IBH Pub., Co., Ltd. New Delhi.
15. Jain, H. K. and Kharwal, M.C. (2003) Plant Breeding: Mendalian to Molecular Approaches. Navrosa Publishing House Pvt. Ltd., New Delhi.
16. Mandal, A.K., Ganguli, P.K., Banerjee, S.P. 1991. Advances in Plant Breeding. Vol 1 and 2, CBS Pub. & Distributors.
17. Sharma, J. R. 1994. Principles and Practices of Plant Breeding. Tata McGraw Hill. Pub. Co. Ltd. New Delhi.
18. Simmonds, N. W. 1979 Principles of Crop Improvement. Longman, London and New York.

BO 1.4 Environmental Botany

(Theory - 4 Credits)

Credit – 1 (15L)

Environmental Biology: an interdisciplinary science, its scope and necessity.

Ecosystem: concept and dynamics of ecosystem, components, food-chain, energy flow, succession, ecological stability,, ecological niche, ecological pyramids, recycling, biogeochemical cycles and types of ecosystems. Population ecology, community structure formation and composition, vertical and horizontal distribution and plant life-forms 8L

Aquatic Ecosystem: Classification, composition of natural waters, physico-chemical properties of water, kinds of aquatic habitats (freshwater and marine), Biological community: its composition distribution, adaptation and productivity. Ecology of coastal and marine ecosystem, ecology of inter-tidal belt. 5L

Terrestrial Ecosystem: Phytogeographical regions of India and their classification. Major Basis and basis of biome classification and their biotic elements and adaptation. 2L

Credit – 2 (15L)

Pollution Ecology: Environmental pollution-types and sources

Air Pollution: Classification, primary and secondary air pollutants, mode of their deposition, Effect of air pollution on plants. Process of acidification and its impacts on aquatic and terrestrial ecosystem.

Environmental Monitoring: principles and methods used in monitoring of pollution and indicator plants
Global Climate Change: Green house gases, their major sources and impact on climate. Kyoto protocol: major recommendations, Concept of CDM, Carbon credits, Carbon sequestration-methods of estimation, clean technology and its importance. Concept and role of green belt.

Credit-3 (15L)

Water Pollution: Sources and types and their effect on water quality and organisms. Eutrophication: natural and manmade, measures of Eutrophication, indicator organisms.

Pollution Monitoring: physical, chemical and biological parameters used and their significance. Various biological indices including algal indices. Process of bioaccumulation and biomagnification.

Solid Waste: types and sources, process of their disposal, composting, vermiculture, recycling for energy and soil conditioning.

Credit –4 (15L)

Environmental Management

Environmental Impact Assessment: EIP process, principle, scope and content with case studies
Environmental audit. Environmental legislation in India. Concept of sustainable development

Conservation ecology: conservation of soils, water, wetlands.

Waste treatment: biological methods used in treatment of sewage. Sludge treatment and its applications.

Phytoremediation: concept, process and application in decontaminating soils and water.

Environmental management System ISO 14000 series.

Various Conventions and their importance in protection and conservation: Review of various national and International obligations in environmental protection such as CITIES, RAMSAR, Montreal, Basal, CBD

Books:

Fundamentals of Ecology by E.P. Odum

Environmental Chemistry by A.K. De

Environmental Biology by Biswarup Mukherjee Tata McGraw Hill

Modern Concepts of Ecology by H.D.Kumar

Environmental Science by Turk and Turk

Manual of Field Ecology by R. Mishra

Plant Ecology by Ambhast

Air Pollution Vol I by A.C. Stern

Environmental Impact Assessment by Larry Canter, McGraw Hill

Environmental management by Biswarup Mukherjee V. Publication House

Pollution Biology: Hynes

BO1.5 PRACTICALS BASED ON BO1.1 (2C)

PRACTICALS ON ALGAE– (1 AND 3 COMPULSORY) (ANY 6 FROM 2)

1. HANDLING OF COMPOUND MICROSCOPE AND METHODS TO STUDY ALGAE (1P)
2. MORPHOLOGICAL OBSERVATIONS, DOCUMENTATION (DESCRIPTION AND ILLUSTRATIONS) AND CLASSIFICATION WITH REASONS OF TAXA BELONGING TO
 1. CHLOROPHYTA (3)
 2. CHAROPHYTA (1)
 3. PHAEOPHYTA (1)
 4. PHODOPHYTO (1)
 5. CYANOPHYTA (1)
 6. MINOR GROUPS (1)
 7. USE OF MONOGRAPHS..... (1)

PRACTICALS ON FUNGI (2C)

STUDY OF THE REPRESENTATIVE GENERA BELONGING TO MYXOMYCOTINA, MASTIGOMYCOTINA, ZYGOMYCOTINA, ASCOMYCOTINA, BASIDIOMYCOTINA AND DETEUROMYCOTINA, WITH RESPECT TO OBSERVATIONS MADE BASED ON TISSUE DIFFERENTIATION. ACCESSORY ORGANS, ASEXUAL AND SEXUAL STRUCTURES, FRUIT BODY-ASCOCARP / BAIIDIOCARP.

STUDY SHOULD BE BASED ON GENERA COLLECTED FROM THE REGULAR FIELD TRIPS AND OUTSIDE TOURS. (ANY 40 GENERA, AT LEAST SIX FROM EACH SUBDIVISION).

PRACTICALS ON BRYOPHYTES: (2 CREDIT)

Morphological, anatomical and reproductive studies of the following members:

MARCHANTIALES : *RICCIA, RICCIOCARPOUS, MARCHANTIA, , LUNULARIA, ASTERELLA, DUMORTIERA, PLAGIOCHASMA, TARGIONIA AND CYATHODIUM.*

METZGERINEAE : *FOSSOMBRONIA, PETALLOPHYLLUM, PELLIA, PALLAVICINIA, RICCARDIA AND METZGERIA.*

JUNGERMANNIEAE : *PORELLA, FRULLANIA.*

TAKAKIALES : *TAKAKIA.*

ANTHOCEROTALES : *ANTHOCEROS, NOTOTHYLUS.*

MUSCI: *SPHAGNUM, POLYTRICHUM, FUNARIA*

STUDY OF AVAILABLE FOSSIL BRYOPHYTES .

BO 1.6 Practicals on BO 1.2 and 1.3

Biochemistry and Physiology (Any 12)

1. Preparation of solutions of different concentrations. Conductivity and pH measurements
2P
2. Enzyme assays – extraction and estimation of enzyme activity 2P
3. Purification of enzyme by ammonium sulphate precipitation / gel filtration 2P
4. Effect of pH and enzyme concentrations on enzyme activity 2P
5. Effect of substrate concentration on rate of enzyme action and calculation of K_m .
1P
6. Estimation of soluble proteins in germinating and non-germinating seeds by Lowry / Bradford's method 2P
7. Estimation of total amino acids in germinating and non germinating seeds 1P
8. Isolation and estimation of chlorophylls and carotenoids. Separation of pigments using column chromatography. Determination of absorption maxima of each pigment
4P
9. Estimation of ascorbic acid in ripe and unripe fruits 1P
10. Assaying IAA oxidase activity in green and senescent leaves 2P
11. Studies on induction of amylase activity by GA3 in germinating cereal grains 2P

Genetics and Plant breeding(Any 12)

1. Preparation of stains, Fixatives, preservatives and pretreatments to plant material. 1P
2. Karyotype analysis, Preparation of somatic C- metaphase chromosomes of appropriate material using camera lucida drawing and Karyotype analysis 3P
3. Study of meiotic configurations in Maize/ *Allium*, *Rheo*/ *Aloe*, *Tradescantia*. (prophase I, chiasma frequency). 4P
4. Study of chromosomal aberrations in irradiated plant material. 1P
5. Study of polygenic inheritance. 1P
6. Problems of Mendelian inheritance and estimation of gene frequencies and heterozygotic frequencies, population genetics and Linkage. 2P
7. *Neurospora* tetrad analysis. 1P
8. Handling of *Drosophila* for study of mono, dihybrid and sex linked inheritance. 4P
9. Linear differentiation of chromosomes through banding techniques such as C-banding, G-banding and Q-banding. 2P
10. Penetrance and expresivity of PTC tasting ability in humans and tongue rollers / non-rollers. 1P
11. Floral biology, study of pollen viability, germination in vitro and staining of any two major crops. 1P
12. Study of Monohybrid and Dihybrid crosses and interactions. 2P
13. Study of Quality traits in rice, cotton / wheat/ Soybean/ *Brassica*. 1P
14. Use of Colchicine for induction of polyploidy in appropriate plant material. 2P

BO1.7 Environmental Botany Practicals 2C (8P)

1. Collection of water samples (clean and polluted) and analysis for algal community and estimation of DO, Co₂, chlorides, alkalinity, and BOD 3 P
2. Comparison of stomata index and pollen fertility of the plants from polluted and clear areas 2 P
3. Vegetation studies: Determination of minimum number of quadrates, Estimation of frequency, abundance, dominance, I.V.I., richness, life form of vegetation using suitable method and canopy studies. 4 P
4. A visit to restored habitat such as Nallah Garden /watershed project/ Green belt/ wastewater treatment plant having biological treatment method 2 P

BO 2.1 Systematics of Vascular Plants –Pteridophytes, Gymnosperms and Angiosperms

Credit I - Pteridophytes

(15L)

Systems of classification1L

Distribution, morphological, anatomical, reproductive studies and comparative account of sporophytes and gametophytes and interrelationships of the following orders:

Psilotales and Lycopodiales (1L), Selaginallales and Isoetales (1L), Equisetales (1L), Ophioglossales (1L), Marattiales (1L), Osmundales (1L), Filicales (1L), Marsileales (1L), Salviniiales (1L), Telome concept (1L), Soral evolution (2L), Parthenogenesis, heterospory and seed habit (1L), Economic importance of Pteridophytes (1L) and fossil pteridophytes (2L)

Credit II - Gymnosperms

(15L)

Systems of classification1L

Distribution, comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology and interrelationship of living Cycadales (3L), Ginkgoales (2L), Coniferales (3L), Taxales (1L), Gnetales (3), Economic importance of gymnosperms (1L) and fossil Gymnosperms (2L).

Credit III – Angiosperms

(15L)

1. Systematics – Definitions, Scopes and Phases 1L
2. **Data and selection of characters for systematics from following sources – Morphology, Anatomy, Embryology, Cytology, Palynology Phytochemistry, Micromorphology, Molecular biology. (at least two examples from each source).** 6L
3. Biosystematics – Principles and procedures – Intraspecific classification, Biosystematic categories 3L
4. Floristics – Principles and procedures 2L
5. Botanical gardens and Herbaria as resource institutes for systematics 2L
6. Numerical Taxonomy 1L

Credit IV**(15L)**

1. Basis, outline and special features of Cronquist's system of classification (1988) of flowering plants. 2L
2. Salient features of the following subclasses of Magnoliopsida – Magnoliidae, Hamamelidae, Caryophyllidae, Dilleniidae, Rosidae and Asteridae Patterns of Relationships within each group. 6L
Salient features of the following subclasses of Liliopsida, Alismatidae, Arecidae, Commelinidae, Zingiberidae and Liliidae – Patterns of Relationship within each group 5L
3. Systematics of (any one group) Aquatic angiosperms, Parasitic angiosperms, Epiphytic angiosperms, Insectivorous angiosperms, Mangroves 2L

BO 2.2 Cell Biology

Credit 1 Cell organelles(I) –functional aspects

1. Cell wall – biogenesis, structure and function. Growth 3L
2. Cell membranes: molecular organization, Fluid mosaic model, transport across membranes- facilitated diffusion, carrier & channel proteins, transporters, active transport 4L
Molecular organization of chloroplast and mitochondrial membranes. 3L
3. Plasmodesmata – Structure and role in movement of molecules, virus transport 2L
4. Vacuoles – Tonoplast membrane, biogenesis, transporters, role as storage organelle, transport across vacuolar membrane 3L

Credit 2 Cell organelles(II) –functional aspects

1. Endoplasmic reticulum- Role in synthesis and transport of secretory proteins 2L
2. Golgi complex – role in sorting , storage and secretion, 2L
3. Lysosomes- membrane integrity and role 1L
4. Glyoxysomes and Peroxisomes- structure, enzymes and functions 1L
5. Cytoskeleton – composition and organization of microtubules, microfilaments. Tread milling and their role in cell division, signaling and intracellular traffic. Role in motility ,flagella - Structure and organization. 4L
6. Nucleus – Structure, organization and regulation of nuclear pore complex. Transport across nuclear membrane. 2L
7. Ribosomes – Structure, assembly and dissociation of subunits, function. 2L
8. Biogenesis of chloroplasts and mitochondria 1L

Credit – 3 Signal transduction

1. Nuclear-organelle signaling during plastid development 2L
2. Signal transduction: Receptors and G-proteins, phospholipid signaling, Ca-calmodulin cascade, diversity in protein kinases and phosphatases 8L
3. Specific signaling mechanisms with suitable examples – biotic and abiotic stress, ABA induced stomatal closure, 5L

Credit – 4 Cell cycle, aging and cell death

1. Cell Cycle – Phases of Cell Cycle, functional importance of each phase, Molecular events during cell cycle, Check points, Cyclins and protein kinases, MPF (maturation promoting factor), Regulation of cell cycle. Methods to study cell cycle – labeled mitotic curve, flow cytometry, use of mutants. 7L
2. Cell aging and cell senescence, programmed cell death- molecular aspects, regulation of cell death, PCD in response to stress 4L
Apoptosis- Role of different genes, cell organelles during apoptosis, genetic control of apoptosis. 3L

Reference Books:

1. Molecular Biology of the cell (1998) Edt. Alberts, Bray, Lewin, Raff et al
2. Molecular Cell Biology 3rd edn, (1995) Lodish, Baltimore, Berk, Lawrence, et al, Scientific American Books, N.Y.
3. Cell and Molecular Biology (1988), 8th edn. De Robertis and De Robertis, Info-Med, Hong Kong

4. Biochemistry and Molecular Biology of Plants (2000) Edt. Buchanan, Griseem and Jones, American Soc. Plant Biologists, Waldorf
5. Genes (2000), edn7, Lewin B, Oxford Univ. Press, Oxford
6. Practical Biochemistry: Principles and Techniques, 4th Edition, Wilson K and Walker J, Cambridge University Press, Cambridge, 1994
7. Physical Biochemistry, Freifelder D,

BO2.3 Molecular Biology and Genetic Engineering

Credit - 1

1. Aberrant structures of DNA 2L
2. Melting and reassociation of DNA, Cot curves and kinetic complexity of DNA, repetitive and unique sequences, C value paradox. Rot curves and gene expression 3L
3. Structure of chromatin. Alteration in chromatin structure during transcription, nucleosome positioning. Chromatin remodelling 3L
3. Initiation and termination of DNA replication, molecular machinery of DNA replication in prokaryotes and eukaryotes. 3L
4. DNA damage and repair. 2L
5. Molecular mechanism of recombination and transposition 1L

Credit - 2

- 1. Transcription units, RNA polymerases, initiation and termination of transcription in prokaryotes and eukaryotes 3L**
2. RNA processing – Processing of tRNA, rRNA. mRNA processing - G capping, Intron splicing, polyadenylation. mRNA localisation 4L
4. Regulation of transcription - Operons, repressors and inducers, positive and negative control, regulation of lytic and lysogenic cycles in phages. 4L
5. Transcription factors in eukaryotes, response elements. Post-transcriptional regulation. 4L

Credit - 3

1. Protein synthesis – tRNA charging, ribosomal organisation Initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes. Regulation of protein synthesis. 6L
2. Post-transcriptional processing of proteins, Proteases and their role in processing and degradation of proteins 4L
2. Targeting of organelle and secretory proteins. Localisation of membrane proteins. Chaperones and protein folding. 3L
3. Seed-storage proteins and their genes in cereals and legumes 2L

Credit – 4

1. Cloning strategies:
Introduction Enzymes used for making recombinant DNA 2L
Vectors - plasmids, phages, cosmids, phagemids, BACs and YACs 4L
Bacterial transformation 1L
2. Plant transformation: *A. tumefaciens* and *A. rhizogenes*, Ti plasmids and Ri plasmids, transfer of DNA into host by *Agrobacterium tumefaciens*, mechanism of integration of DNA into plant genomes 4L
3. *Agrobacterium*-based vectors *Agrobacterium* mediated transformation 2L
3. Direct DNA transfer into plants using PEG, electroporation, biolistic transfer, in planta transformation 2L

Reference books

1. Genes VI - Benjamin Lewin, Oxford University Press Oxford, 1997
2. Genes VII – Benjamin Lewin, Oxford University Press Oxford, 2000
3. The Biochemistry of Nucleic acids – Adams, RLP, Knowler, JT and Leader DP, Chapman and Hall, 1986
4. Molecular Biology of the Cell – Alberts, B, Bray, D, Raff, M, Roberts, K and Watson JD, Garland Publishers, 1999
5. DNA cloning 1: A Practical approach; Core techniques, 2nd Edition, IRL Press 1995
6. Plant Molecular Biology: A Practical approach. Shaw CH (ed) IRL Press, 1988

BO2.5 Practicals based on BO2.1

PRACTICALS ON PTERIDOPHYTES: (2 credit - 8P)

Morphological, anatomical and reproductive studies of the following members:

Psilotales: Psilotum, Tmesipteris, Lycopodiales: Lycopodium

Selaginellales: Selaginella, Isoetales: Isoetes, Equisetlaes: Equisetum

Ophioglossales: Ophioglossum, Botrychium, Helminthostachys, Marattiales: Angiopteris,

Osmundales: Osmunda Filicales: Anemia, Lygodium, Gleichenia

Ceratium,,Goniopteris,Phymotodes, Pteris, Acrostichum, Blechnum, Platycerum, Pleopeltis, Chelanthus, Ceratopteris, Athyrium, Adiantum.

Study of available fossil of Pteridophytes along with living specimens.

PRACTICALS ON GYMNOSPERMS (1 credit - 4P)

Cycadales: a. external morphology of vegetative parts of *Cycas* sp, *Zamia*, *Encephalrtus*

b. megasporangiate stobili and megasporophylles of *Cycas* sp., *Ceratozamia*, *Zamia*, *Encephalrtus*

c. microsporangiate stobili and microsporophylles of *Cycas* sp., *Ceratozamia*, *Zamia*, *Encephalrtus*

d. Gametophytes and embryogeny: i) *Microcycas* - free nuclear stage,

ii) *Zamia* – archeogonia and proembryo iii) *Cycas* - embryo

e. Anatomy: T.S. of rachis and pinnea *Cycas*, *Zamia*

Coniferales and Taxales:

Pinus, *Cupressus*, *Araucaria*, *Agathis*, *Podocarpus*, *Taxodium* –

a. Make a double stained semi permanent preparation of wood of any two of the above genera, which includes T.S., T.L.S and R.L.S of wood.

b. Study of male cones, microsporophylls and microspores – at least one genus from each family.

c. Study of female cones, ovuliferous scales of *Pinus*, *Cupressus*, *Araucaria*, *Agathis*, *Podocarpus*, *Taxodium*

d. Gametophytes and embryogeny of *Pinus* – Archegonia, proembryo and suspensor.

Gnetales:

Study of habit, external morphology of *Gnetum*, and *Ephedra*

T.S., T.L.S and R.L.S of wood of *Gnetum*

Morphology of reproductive parts –

i) Male strobilus, microsporophylls, pollen grains of *Gnetum* and *Ephedra*

ii) Female strobilus of *Gnetum*

Study of available fossil Gymnosperms along with living specimens.

PRACTICALS ON ANGIOSPERMS (3 credit - 12P)

Tools of taxonomy – Types of tools, Field Tools, Laboratory Tools and Library Tools

Taxonomic literature – Check lists, Floras, Keys, Monographs and Laboratory identification manuals

Methods of field work, Plant collection and documentation of the data, Herbarium preparation.
 At least three field visits to the campus. Maintaining field diary. Report writing, field reports,
 Non destructive collection 2P

Comparative studies of families from at least three major groups (series or orders) of
 dicotyledonous and 2 major groups of monocotyledons 3P
 Identification of plants up to species giving reasons 2P
 Preparation of artificial keys 2P
 Chemotaxonomy 1P
 Palynotaxonomy / Cytotaxonomy 1P

BO2.6 Practicals based on BO 2.2 and BO 2.3

Cell Biology (3Credits - any 14 practicals)

1. Differential centrifugation for isolation of cell fractions – Nuclear fraction 1P
2. Isolation of chloroplasts to study:
 - a. Hill reaction to measure intactness,
 - b. measurement of size of chloroplasts using micrometry
 - c. chlorophyll estimation 2P
3. Isolation of mitochondria for
 - a. Estimation of succinic dehydrogenase activity
 - b. Microscopic observations using MitoTracker Green FM/
MitoTracker Red 580/ Janus green B 2P
4. Isolation of lysosomal fraction and estimation of acid phosphatase activity 1P
5. Study of electron micrographs of cell organelles 1P
6. Study of cell cycle using BrdU (demonstration) 1P
7. Isolation of protoplasts and viability staining to determine % viability. 1P
8. Study of metaphase nucleus: Localization of euchromatin and
heterochromatin. 1P
9. Cytochemical studies of special cell types- guard cells, senescent cells,
bundle sheath cells, meristematic cells, laticiferous cells, glandular cells,
pollen grains 2P
10. Study of induced cell senescence in leaf discs 1P
11. Study of programmed cell death in plants 1P
12. Ouchterlony immunodiffusion technique for testing specificity of antigens
and antibodies. 1P

Molecular Biology (4 Credits – Any 14 practicals)

1. Isolation of plasmid DNA and quantification 2P
2. Determining absorption maximum of DNA and protein 1P
3. Electrophoretic separation of plasmid isoforms 1P
4. Restriction digestion of plasmid DNA, electrophoresis and molecular weight
determination of DNA fragments. 2P
5. Transformation of *E.coli* with plasmid, selection and confirmation of
transformants. 2P
6. Isolation of plant genomic DNA and quantification 2P

7. Effect of temperature and alkali on absorbance of DNA – hyperchromicity 1P
6. Separation of seed-storage proteins from leguminous seed and quantitation of each fraction 2P
7. SDS-PAGE separation of seed storage proteins from legumes. Determination of molecular sizes of the globulin subunits. 3P

BO 2.41: Plant-organism interactions

Credit – I Plant Diseases

General aspects:

Concept of disease in plants, history of plant pathology, significant plant diseases, losses caused by plant diseases, basic procedures in the diagnosis of plant diseases (3L)

Host range of pathogens, stages in the development of disease, pathogenesis and plant physiological functions, host defensive (4L)

Genetics of plant disease:

Genes and disease-variability of organisms, stages of variation in pathogens, Type of resistance to pathogens and Genetics of virulence in pathogens and of resistance in host plants, Breeding of resistant varieties and genetic engineering techniques for disease resistance.

(8L)

Credit II – Host-Pathogen Interactions

Plant host-pathogen interaction, preexisting structural and chemical defenses, Induced structural and biochemical defenses, hypersensitive response, detoxification of pathogen toxins by plants, system acquired resistance (5L)

Environmental factors on the development of plant disease, plant disease epidemiology, forecasting plant disease epidemics (5L)

Control of plant diseases, physical chemical and biological control methods, Integrated control of plant disease in perennial and annual crops. (5L)

Credit III

Plant interactions with other plants, mycorrhizae and symbiotic bacteria (15 L)

- a) Plant interactions with mycorrhizae 4L
- b) Plant interactions with rhizobia and endophytic algae 4L
- c) Parasitic plants, allelopathic interactions 7L

Credit IV

Plant interactions with insects and animals (15L)

- a) Interactions between flowering plants and pollinators 7L
 - i) insects with special reference to bees
 - ii) birds, bats and higher animals
- b) Carnivorous plants 2L
- c) Interaction between plants and nematodes. 2L

- | | |
|---|----|
| d) Interaction between plants and insect pests. | 2L |
| e) Insect attractants and repellants | 2L |

Reference Books:

- 1) Allelopathy- organism, Processes and application by Indrajit K.M.M. Dakshini and F.A. Einnelling publication American Chemical Society Washington DC. (1995)
- 2) Allelopathy Volume -2 Plant Protections by S.S. Narwal Ramsigh R.K. Wadia. Scientific Publication Jodhpur – (2004)
- 3) Weed Biology and Management by Indrajit, Kluwer Academic Publisher- London (2004).
- 4) Kuijt J. () Biology of parasitic flowering plants.

BO 2.42 Post harvest Technology

Credit I – Seed technology

(15 L)

Seed germination -Physiology of seed maturation, biochemical changes during germination. Role of promoters and inhibitors. (4L)

Seed dormancy- types, mechanism, endogenous and exogenous factors affecting dormancy. Methods of breaking and inducing dormancy. Seed vigour, factors affecting seed vigour, physiological and genetic basis. Seed viability and longevity, physiology of seed ageing (5L)
 Cultivar purity testing: Principles and methods, Electrophoresis of protein and isozymes, DNA fingerprinting and their use in varietal registration and purity. DUS testing. Plant variety protection (PVP), UPOV guidelines and Seeds Act. (6L)

Credit II – Post-harvest changes in plant products

1. Principles and practices of post harvest management of horticultural produce and Importance of post harvest technology (2L)
2. Structure, composition and nutritional qualities of fruits and vegetables. (2L)
3. Maturity indices, harvesting, grading methods. (2L)
4. Biochemical changes during ripening, senescence and storage of fruits and vegetables. (2L)
5. Respiration, transpiration and ethylene biosynthesis during ripening and storage and there impact on storage quality. (2L)
6. Prestorage, chemical treatments for retaining, improving and regulating ripening, senescence and storage. (2L)
7. Methods / techniques used for improving vase life of cut flowers (3L)

Credit III- Storage and packaging

1. Storage systems -Precooling, low temperature controlled atmosphere (CA), modified atmosphere (MA) and Hypobaric storage, On farm storage (3L)
2. Storage requirements of different fruits and vegetables (2L)
3. Storage disorders, Spoilage and there control. (4L)

4. Packing, Grading and transport for local and export market. (3L)
5. Requirement/ standards of export marketing of stored fruits and vegetables. (3L)

Credit IV - Plant processing, storage and quarantine:

Principles, scope and prospects, plant quarantine operations in India. New seed policy. Domestic and international quarantine. (2L)

Plant protection convention and international cooperation in plant quarantine. Pest risk analysis. Techniques for the detection of insects, mites, nematodes, fungal, bacterial pathogens and viruses. Salvaging the germplasm. New exim policy. Plant quarantine authority. (3L)

Different methods of seed storage. Preparing seed for processing. Seed treatments-methods of seed treatment. (3L)

Conservation of orthodox and recalcitrant seeds. Factors influencing storage losses. Storage methods and godown sanitation. Storage pests and their control. (5L)

Seed quality enhancement. Synthetic seeds, embryo encapsulation. Cryopreservation, storage, desiccation tolerance. (2L)

References:

1. **Burton, W.G.** 1982. Post harvest technology of fruits and vegetables. Blackwell sciences Ltd., Oxford, U. K.

2. **Chadha , K. L. and O.P. Pareek.** 1993(Eds.) Advances in horticulture. Vol. 1-4
Malhotra Publishing House, New Delhi.

3. **Chadha , K. L. and G. Kalloo.**1993 (Eds.) Advances in horticulture. Vol. 5-6.
Malhotra Publishing House, New Delhi.

4. **Pantastico, Er. B.** (Ed) 1975 Post harvest Physiology, handling and Utilization of Tropical and Subtropical fruits and Vegetables. AVI Publ. Co. Westport.

5. **Ryall, A. L. and W.J. Lipson,** 1979. Handling, transportation and Storage of I fruits and . Vegetables, Vol.1, vegetables and melons, AVI Publ. Co. Westport.

6. **Ryall, A. L. and W.T. Pentzer,** 1982. Handling, transportation and Storage of I fruits and Vegetables, Vol.2,Fruits and Nuts , AVI Publ. Co. Westport.

7. **Salunkhe, D. K. and B.B. Desai.** 1984 . Post harvest Biotechnology of Fruits and vegetables
Vol I CRC Press, Boca Raton

8. **Thompson A. K.** 1996. Post harvest physiology of food crops . Longman , London

9. **Willis , R,B.H., T.H. Lee, D. Graham , W. B. Mc Glasson and E.G. Hall,** 1981.

Post harvest : An Introduction to the physiology and handling of fruits and vegetables. AVI Publ. Co. Westport.

10. Association of Official Seed Analysts, 1991. Cultivar purity testing handbook, AOSA, cont. No. 33-88p.
11. Bewley, J.D., and L. Black, 1982. Physiology and Biochemistry of seeds in relation to germination, Vol.1 and Vol.11, Springer-Verlag, Berlin Heiderberg, Neew York.
12. Cooke R.J. and J.C. Reeves (1998). Cultivar identification: General discussion and review of new methods. In Encyclopedia of seed production of world crops. Ed. A. Fenwick Kelly and RAT George. John Willy and sons, West Sussen, England.
13. Hames B.D. and D. Rickwood (1990). Gel electrophoresis of proteins. A practical approach. Oxford University Press, Oxford, England.
14. Handbook of variety testing growth chamber - Greenhouse testing procedures: Variety identification. Ed. R.C. Payne. The International Seed Testing Association, Zurich, Switzerland, 1993.
15. Handbook of variety testing. (1992). Electrophoresis Handbook: Variety identification Ed. R.J. Cooke, International Seed Testing Association, Zurich, Switzerland,
16. Handbook of variety testing. (1993). Rapid chemical identification Technique Ed. R.C. Payne. International Seed Testing Association, Zurich, Switzerland,
17. Jaima Kigel, J. and G. Galili, 1997. Seed development and germination. Marcel Dekker, New York.
18. Khan, A.A. 1977. The physiology and Biochemistry of seed dormancy and germination, North Holland Publishing Co., Amsterdam, New York.
19. Kozlowski, T.T. 1972. Seed Biology, Vol.1, Academic Press, London.
20. Lang. G.A. 1997. Plant dormancy, physiology, biochemistry and molecular biology, Cab International U.K
21. Mayer, A.M. and A.P. Mayber, 1989. Germination of seeds, PergamonPress, Oxford.
22. Ovcharov, K.E. 1977. Physiological basis of seed germination, Amerind Publishing Co., New Delhi and New York.
23. Pursglove, J.W. 1977. Tropical crops of Monocotyledons, Longmans, Green and Co., Ltd., London.
24. Seed Testing Rules (1999). International Seed Testing Association, Zurich, Switzerland.
25. Thompson, J.R. 1977. Advances in Research and Technology of Seeds, part - 1,3 & 4, centre for Agrl. Publishing and Documentation, Washington.

BO2.43 Plant Biomass Production

Credit 1 Laboratory cultures of algae

Method of algal isolation,

Culture of algae: Necessity, types, materials methods, media, isolation techniques, maintenance and growth of algal cultures, synchronous, continuous, mass and in vitro cultures, cryopreservation of algae.

Scaling up, Algal grouping, Strain selection, Growth kinetics, Measurement of algal growth, Large scale cultivation, processing, Yield, Chemical composition, Nutrition, quality standards

Credit 2 Fungal biomass production and use

Fungal cultures for production of metabolites- primary and secondary: Bioconversion and Biotransformations, Organic Acids, Enzymes, antibiotics ergot alkaloids, steroids, toxins.

(3 L)

Scaling up of fungal cultures – fermentors, applications in brewing industry,

Organic Acids, Enzymes, antibiotics ergot alkaloids, steroids, toxins. (6L)

Mushroom culture (6L)

Credit 3 Plant propagation

Fodder crops 5L

Types, cultivation, harvesting and utilization.

Case study – Grasses, legumes and others.

Alternative Energy crops 5L

Types, cultivation, harvesting and utilization.

Case study – Jatropha, forest based oil seed plants.

Multipurpose trees 5L

Types, cultivation, harvesting and utilization.

Fuelwood, timber, nitrogen fixing trees

Credit 4

Biomass production in vitro

Techniques – culture systems, growth of callus and suspension cultures 7L

Micropropagation

a. Stages of micropropagation 4L

b. Factors affecting micropropagation 4L

3. Multiplication rates and field trials

BO 2.44 Natural Plant Products

Credit 1:

Plant products from various sources

Natural Products from Fungi – Industrial and non industrial fungal metabolites from fungi like mycotoxins, pigments, organic acids, alcohols, enzymes, antibiotics etc. medicinal mushrooms, , lichens as a Source of Bioactive Compounds, agricultural metabolites like mycoproteins, zearalone, gibberellins, aroma and flavoring compounds (8)

Natural products from algae – nutraceuticals: single cell proteins, agar-agar and pharmaceuticals, Isolation and enrichment, screening strategies, commercial aspects (4)

Other groups like Bryophytes, Pteridophytes and Gymnosperms used for pharmaceuticals (3)

Credit 2:

Secondary metabolite production using tissue culture:

- | | |
|--|----|
| 1. Metabolism in cultured cells, Major secondary metabolism pathways, | 2L |
| 2. Regulation of secondary metabolite pathways and compartmentalization | 4L |
| 3. Types of culture systems used for secondary metabolite production | 2L |
| 4. Improving secondary metabolite production in culture | |
| a. Manipulation of nutrient media, precursor additions | 2L |
| b. Immobilization of cells | 1L |
| c. Elicitation using biotic and abiotic elicitors | 1L |
| d. Biotransformation | 1L |
| 5. Screening and selection of high secondary metabolite producing cell lines | 2L |

Credit 3:

Biotechnological applications:

- Genetic transformation techniques for improving secondary metabolites (6)
- Metabolic engineering of microbes or plants as a possible source of useful products like: fibers, pigments, pharmaceuticals, nutraceuticals, flavoring agents (6)
- Metabolic profiling and identification of probable drug molecules (3)

Credit 4:

Commercialization of natural products:

- Preservation and shelf life of natural products used commercially (1)
- Processing for pharmaceuticals (with case studies) (1)
- Processing for nutraceuticals and cosmeceuticals (with case studies) (4)
- Pharmacognostic techniques: Methods of standardization of crud drugs (raw material) and their evaluation (6)
- Ethnobotany-contribution to modern medicine, applications. (3)

Reading material:

1. Engineering plants for commercial products and applications. Eds. Collins GB and Shepherd RJ, NY Acad. Of Science Publishers 1996
2. Essentials of Genomics and Bioinformatics, Senson CW ed. Wiley-VCH Publishers, NY, 2002.
3. Secondary Metabolism in Plant Cell Cultures, Eds. Morris, A.H. et al., (1986). Cambridge Univ. Press, Cambridge, U.K.
4. Plant Tissue Culture as a Source of Biochemicals, Ed. Staba, E.J., (1980) C.R.C. Press. Boca Raton, Florida.
5. Primary and Secondary Metabolism of Plant and Cell Cultures, Ed. Kurz W.G.W., (1989). Springer Verlag, Berlin.
6. Biotechnology in Agriculture and Forestry – vol. 4, Ed. Bajaj, Y.P.S., (1988). Springer-Verlag, Berlin, Heidelberg, New York, Tokyo.
7. Cell culture and somatic cell genetics of plants Vol. 4, ed. Vasil I.K. (1986) Academic Press, N.Y.
8. Secondary products from plant tissue culture. Edt. Charlwood B.V. and Rhodes MV. (1999), Clarendon Press, Oxford.
9. Plant cell culture: Secondary metabolism towards industrial application, Edt. Dicosmo F and Misawa M, (1996), CRC press, Boca Raton ,N.Y.
10. Biotechnology: Secondary metabolites, Edt. Ramawat K G and Merillon J M, (1999) Oxford IBH Publishing Co., New Delhi
11. Biochemistry and molecular biology of plants , Buchanan BB, Grussem W and Jones RL (2000) IK International Pvt Ltd. New Delhi
12. Metabolic engineering of plant secondary metabolites. Verapoorte r and Alferman HW (eds) Kluwar Academic Publ., Netherlands

BO 3.1 Developmental Botany 4 Credits

Credit I	15L
1. Plant development – Concept, Definitions and unique features.	1L
2. Processes basic to plant development	
a) Cell growth, division and differentiation	
b) Competence, determination, commitment specification, differentiation Dedifferentiation and redifferentiation.	
c) Polarity and symmetry	
d) Integration and organization of cells into tissues; tissues into organs, organs into whole plant.	
e) Cell – cell interaction	
f) Programmed cell death.	3L
3. Factors controlling plant development – intrinsic and extrinsic.	2L
4. Vegetative development – structure and organization of seed embryo.	
Embryonal axis – meristems	
Meristems as dynamic centers of cell regeneration	
Seed Maturation, Seed germination – establishment of seedling organs	
Organ development – Primordium to organ.	5L
5. Juvenility – characteristics, transition to adult phase.	1L
6. Coordinated development – pattern formation – branching, phyllotaxy aestivation Developmental basis of plant forms (in terms of longevity and habit)	3L
 Credit II	 15L
1. Transition from vegetative to reproductive phase – morpho – histo – cytochemical changes in vegetative plant body	2L
2. Development of stamen anther sporogenous tissue – microspores – pollen – male germ unit.	
2L	
3. Development of Carpel – Ovule – Sporogenous tissue – megaspore – female gametophyte – female germ unit.	
3L	
4. Double fertilization and triple fusion. interaction between pollen and gynaecial tissues	
	3L
5. Zygote – ultrastructure, patterns of development till globular stage	2L

6. Developmental routes to Parthenogenesis, Parthenocarpy, Apomixis

2L

7. Androgenesis and gynogenesis *in vivo*

1L

Credit III

15L

1. Intrinsic and extrinsic factors regulating plant development

1 L

2. Light mediated regulation of vegetative and reproductive development

3 L

3. Hormonal control of vegetative and reproductive development

3 L

4. Cell lineages, cell fate mapping, positional information, techniques for studying development specific gene expressions.

1 L

5. Molecular genetics studies of :

(a) embryogenesis and seedling development

2L

(b) root, shoot and leaf development

2 L

(c) Gene expression during transition to flowering and flower development

2 L

(d) Molecular genetics of the expression of self-incompatibility.

1 L

Credit IV

15L

1. *In vitro* culture as an experimental system for Developmental Botany

2L

2. Developmental processes leading to response of explant *in vitro* – dedifferentiation, redifferentiation, cytodifferentiation

2L

3. Response(s) *in vitro* – continuation of predestined growth and development, callusing, organogenesis and embryogenesis (direct and indirect.)

3L

4. Androgenesis and gynogenesis *in vivo*

1L

5. Factors affecting the response(s) of the explant *in vitro*

2L

6. Protoplast isolation, culture and fusion.

2L

7. Applications of Developmental Botany

3L

References

1. Bhojwani S. S. and Bhatnagar S. P. (1999). The embryology of angiosperms. Vikas Pub. House.
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms
3. Kluwer Academic Publishers.
4. Fahn A (1989) plant anatomy (Third edn) Pergamon Press
5. Gilbert (2006). Developmental biology (8th Edition). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
6. Graham C.F. and Wareing P.F. (1984). Developmental Controls in Animals and Plants
7. Blackwell Scientific Publications
8. Jermy Burgess (1985) An Introduction to Plant Cell Development. Cambridge University Press
9. Johri B. M. and Srivastava P. S. (2001). Reproductive biology of plants. Narosa Pub. House, New Delhi.
10. Krishnamurthy K.V. (1988) Methods in Plant Histochemistry
11. Lewis Wolpert (2002), Principles of Development (2nd edition). Oxford University Press.
12. Lyndon R.F. (1990) Plant Development The Cellular Basis. UNWIN HYMAN
13. Raghavan V. (2000) Developmental Biology of Flowering Plants.Springer Verlag.
14. Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH.
15. Wareing P. F. and Philips I. D. J. (1981) Growth and Differentiation in plants. Pergamon Press
16. Wada M., Shimazaki K., Iino M. (2005). Light sensing in plants. Springer.
17. Davies P. J. (2004) Plant hormones. Kluwer.
18. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Physiology, Maryland

BO3.3 Plant Biotechnology and Bioinformatics

Credit 1

Cloning, sequencing and plant transformation techniques

1. Gene libraries: Genomic libraries, cDNA libraries - Construction, size, vectors used, transformation, selection for transformants 5L
2. Screening of libraries and isolation of specific clones 3L
3. Sequencing strategies: Methods, automated sequencing. Assembling sequences 3L
4. Plant transformation: Improved vector systems, virus-based vectors for transient expression, techniques for improving transformation efficiency, marker free transformants, characterization and handling transformants 4L

Credit 2

Methods for studying gene expression:

- a. Northern hybridization 1L
- b. Differential screening and subtractive hybridization 1L
- c. Differential display of mRNA 1L
- d. DNA microarrays 2L
- e. Gene-tagging and plasmid rescue, promoter and enhancer traps 1L
- f. Yeast two hybrid system to study protein-protein interactions 2L
- g. Electrophoretic mobility shift assay, DNase footprinting, South-Western blotting to study DNA – protein interactions 2L
- h. Site-directed mutagenesis, Insertional mutagenesis 3L
- i. Gene inhibition at RNA level – antisense, co-suppression, RNA interference 2L

Credit 3

Molecular markers and their applications:

- a. Detection of DNA polymorphism using hybridization-based techniques 2L
- b. Detection of DNA polymorphism using PCR based techniques – RAPD, AFLP, SSR polymorphisms, microsatellite-primed PCR 3L
- c. Population genetic analysis, DNA fingerprinting 2L
- d. Phylogenetic analysis, distance-based methods 4L
- e. Mapping and tagging of specific traits, QTL mapping, map based cloning 4L

Credit 4

Bioinformatics

Introduction to databases and retrieving information from databases:

Literature, sequences, structures 3L

Sequence similarities:

- a. Pairwise comparison of DNA and protein sequences, dynamic programming algorithms, FASTA and BLAST. 4L
- Multiple sequence alignments, progressive methods, CLUSTAL, iterative methods, localized alignment in sequences 4L
- b. Determining phylogenetic relationships using DNA and protein sequences, PHYLIP, Maximum parsimony 4L

List of Books

1. Recombinant DNA – Principles and Methodologies. Greene JJ and Rao VS, Marcel Dekker, New York, 1998.
2. Principles of gene manipulation. Primrose SB, Twyman RM and Old RW, 6th Edition, Blackwell Science, Oxford, 2001
3. Differentially expressed gene in plants. Hansen and Harper, Taylor and Francis Ltd. London, 1997.
4. Microarray bioinformatics
5. Engineering plants for commercial products and applications. Eds. Collins GB and Shepherd RJ, NY Acad. Of Science Publishers 1996
6. DNA markers. Eds. Caetano-Anolles and Gresshoff, Wiley-VCH Publishers, NY, 1998
7. Introduction to Bioinformatics. Attwood, T.K., Parry-Smith, DJ, Addison Wesley Longman, Harlow, Essex, 1999
8. Bioinformatics. Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
9. Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003

BO 3.4 Tools and Techniques in Botany

Credit 1

Chromatographic techniques: Paper, thin layer and column chromatography, gel filtration, ion exchange and affinity chromatography, high pressure liquid chromatography, gas chromatography
(8L)

Electrophoretic techniques: Supports, electrophoresis under native, dissociating and denaturing conditions, isoelectric focusing, staining, activity staining (7L)

Credit 2

Microscopy and microscopic techniques: Light, phase contrast, fluorescence, electron, confocal microscopy. Flow cytometry. Micrometry, (7L)

Spectroscopic techniques: Visible, UV, IR spectrophotometry, fluorimetry, circular dichroism, NMR and ESR spectroscopy, atomic absorption and mass spectrometry
(8L)

Credit 3

Radioactive techniques: Isotopes and their half life, detection and measurement of radioactivity - radiation counters, liquid scintillation counters, autoradiography.

Dosimetry (4L)

Immunological techniques: Antibodies and their specificity, antigen-antibody interactions, immunodiffusion and immunoelectrophoresis techniques, immunoassays, western blotting (5L)

Electrochemical techniques: principles of the conductivity bridge, pH meter, oxygen electrode
(3L)

Centrifugation techniques: High speed centrifuges, rotors, ultracentrifugation, density gradient centrifugation (3L)

Credit 4

Dissection, maceration, squash, peeling and whole mount- pretreatment and procedures

Serial sectioning – Double / multiple staining

Histochemical techniques – localization of specific compounds / reactions / activities in tissues

Cytochemical techniques - localization of specific compounds / reactions / activities in cells

B03.5 Biostatistics – 2C

Credit1

Populations and samples	(1L)
Data, graphical presentation of data – frequency distribution	(2L)
Sample means and standard deviations	(1L)
Probability and Probability distributions-	(2L)
Normal distribution -z and t distributions	(2L)
Binomial and Poisson distributions	(3L)
Hypothesis testing and estimation	(4L)

Credit 2

Experimental designs- completely randomised, randomised block and factorial experimental designs	(4L)
Analysis of variance for different experimental designs, F distribution	(4L)
Correlation and regression, linear and non-linear regression, multiple regression	(4L)
Chi-square test for goodness of fit and independence	(3L)

BO 3.6 Practicals on Developmental Botany (5 Credits)

Developmental Botany (20 P)

1. Isolation of shoot apical meristems from seedling, young and mature vegetative plant.
2P
2. Tracing the course of stomatal development and observations on stomatal types.
2P
3. Histological analysis of secondary growth (primary to secondary axis) 2P
4. Observations on 1P
 - a. microsporogenesis and development of male gametophyte
 - b. megasporogenesis and development of female gametophyte
5. Observations on types of endosperm and developmental stages of embryogenesis
1P
6. Dissection and isolation of developing embryo (3 stages) and of endosperm 2P

7. Histochemical analysis and comparison between vegetative SA and reproductively induced SA. 2P
8. Detection of stages of microsporogenesis and male gametophyte. 2P
9. *In vitro* germination of spore/pollen 1P
10. *In vitro* culture of plant organs – tissues and analysis of the response 3P
11. Cytodifferentiation *in vitro* 1P
12. Induction of androgenesis *in vitro* 1P

BO3.7 Practicals on BO 3.3, BO 3.4 and BO3.5 (5C)

Frequency distribution, standard deviation and standard error of mean	(1P)
Use of z, and t tests	(2P)
Chi-square test	(1P)
Analysis of variance	(2P)
Linear regression and correlation	(2P)
Use of fluorochromes to visualise specific cell components / micrometry	(1P)
Conductivity and pH measurements	(1P)
Absorption spectra of BSA / chlorophyll / DNA and determination of absorption maxima	(2P)
Gel filtration	(1P)
Ouchterlony immunodiffusion technique for testing specificity of antigens and antibodies	(1P)
Native electrophoresis and activity staining for peroxidase isozymes	(2P)
Separation of plant pigments using column chromatography	(1P)
HPLC technique (demonstration)	(1P)
PCR amplification of specific DNA sequence, including primer design, separation of PCR products using gel electrophoresis	(2P)
PCR-based molecular markers- RAPDs, ISSR markers	(2P)
Searching for nucleotide and protein sequences using PUBMED	(1P)
Use for BLAST for protein and nucleotide sequence comparison	(1P)
Use of CLUSTAL for multiple sequence alignments	(1P)
Use of PHYLIP/ NT-SYS for phylogenetic analysis.	(1P)

BO4.1 Project work (9C) + Seminar (1C)

1. Students will be assigned to the faculty members for carrying out research projects.
2. Each student will carry out project work amounting to at least 9 hours per week.
3. Projects will be assessed on the basis of a project report and seminar at the end of the semester
4. Internal assessment for the project will be done by the project guide and will be based on monthly progress reports submitted by the student and on the basis of day-to day performance.

BO4.2 Seminar and Review writing (2C)

1. Each student will be assigned one topic for review and one topic for seminar that will be different from the topic of his/her project, but from the same subject area.
2. The review and seminar will have to be based on literature published after 2000.
3. Assessment of the review and seminar will be by examiners appointed by Department examination committee
4. Internal assessment of the review and seminar will be by the project guide.